(54) Title: READER FOR DECODING TWO-DIMENSIONAL OPTICAL INFORMATION
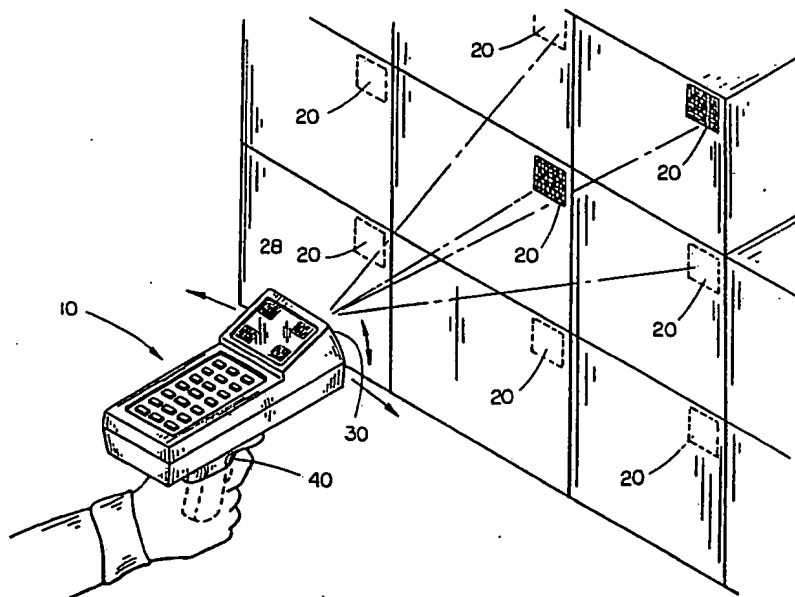
(57) Abstract

A scanner for reading two-dimensional optical information sets is described which includes a housing for supporting a photosensitive array associated with an optical string adapted to focus optical information on the array. Also provided are array and optical string controls for controlling the array and optical string such that the output of selected images on the array are processed via pattern recognition means. Images recognized to contain decodable optical information are displayed and highlighted by a display. In this fashion a user is assisted in aiming, recognizing, confirming the decodability, and decoding images of optical information incident on the array.

READER FOR DECODING TWO-DIMENSIONAL OPTICAL INFORMATION

Cross Reference to Related Applications

The present application is a continuation-in-part of the following copending United States Applications for
5 Patent, Serial № 07/849,771, filed March 12, 1992; and Serial № 07/889,705, filed May 26, 1992.

Background of the Invention

1. Technical Field

The present invention is directed to optical
10 information readers and more, particularly to readers adapted to selectively decode two-dimensional optical information sets.

2. Description of the Prior Art

Conventional bar code symbols have small data storage
15 capacities. This reduces the utility of conventional bar code scanner and reader systems. For example, the 11 digit Uniform Pricing Code found on most supermarket items acts as an identifying number which may be utilized to access information in a database. Codes of this type do
20 not carry information along their vertical axis, and are therefore, less prone to skewing errors during decoding.

Two-dimensional bar code symbols or "portable data files" have recently been developed. With codes of this type access to a database is not required since the code
25 contains the information which would normally be keyed for in a database. Since reliance on a database is not required, information may be accessed and exchanged more readily and reliably. However, in order to decode two-dimensional codes a more sophisticated apparatus is
30 required. This is primarily true since normal vertical

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code redundancy is not present, making code registration, orientation, and condition very important.

Several two-dimensional coding standards have been proposed, e.g., Code 49, 16K, Identicode MLC-2D, and Code

5   PDF417. While such codes are capable of storing information such as price, name of product, manufacturer, weight, expiration date, inventory data, shipping information, and the like; apparatus which assist the user in aiming and decoding two-dimensional codes are not

10   currently available. For example, two dimensional codes might consist of a stack of conventional linear codes. Each line may contain different information, such as (1) pricing information, (2) product name, (3) name of the manufacturer, (4) product weight, (5) expiration date,

15   (6) inventory data, (7) shipping information, and the like. Additionally, a user may require the ability to selectively store or send portions of the decoded bar code symbol.

3. Objects of the Invention

20   Therefore, it is a principal object of the present invention is to provide a scanner adapted to selectively read two-dimensional optical information sets.

Another object of the present invention is to provide a scanner adapted to selectively read two-dimensional

25   optical information sets in ambient light.

Another object of the present invention is to provide a scanner adapted to selectively read two-dimensional optical information sets from a wide range of distances.

Another object of the present invention is to provide

30   a scanner adapted to selectively read two-dimensional optical information sets while assisting a user in aiming the reader.

Another object of the present invention is to provide a scanner adapted to selectively read two-dimensional

35   optical information sets which is economical to manufacture and durable in use.

Finally, another object of the present invention is to provide a scanner adapted to selectively read two-dimensional optical information sets which is efficient in operation, simple in construction, easy to use, and
5   trouble free. These and other objects will be apparent to those skilled in the art.

Summary of the Invention

The present invention discloses a novel scanner for reading two-dimensional optical information sets. In one
10   exemplary embodiment the invention includes a housing for supporting a photosensitive array associated with an optical string means which is adapted to focus optical information on the array. Also provided are array and optical string control means for controlling the array and
15   optical string such that the output of selected images on the array are processed via pattern recognition means. Images recognized to contain decodable optical information are displayed and highlighted by the display means. In this fashion a user is assisted in aiming, recognizing,
20   and confirming the decodability of the image incident on the array.

Brief Description of the Drawings

Other objects and advantages of the invention will become apparent upon reading the following detailed
25   description and upon reference to the drawings, in which:

Figure 1 is a perspective view of a preferred embodiment of the two-dimensional optical information reader showing a user being assisted by the display of the reader in aiming;
30   Figure 2 is a partial top perspective view of the reader illustrating the display wherein the display indicates to a user that a two-dimensional, decodable, bar code symbol may be read if the user adjusts the aim of the reader to the left and above;
35   Figure 3 is a partial top perspective view of the reader illustrating the display wherein the display

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indicates to a user that a two-dimensional, decodable bar code symbol is centered in view and available for reading;

Figure 4 is a highly diagrammatic perspective view of the image capturing elements of a linear array exemplary
5   embodiment of the present invention;

Figure 5 is a highly diagrammatic perspective view of the image capturing elements of a two-dimensional array exemplary embodiment of the present invention;

Figure 6 is a block diagram illustrating the various
10 components of the present invention; and

Figure 7 is a more detailed block diagram illustrating the various components of the present invention.

While the invention will be described in connection
15 with a preferred embodiment, it will be understood that it is not intended to limit the invention to that embodiment. On the contrary, it is intended to cover all alternatives, modifications and equivalents as may be included within the spirit and scope of the invention as defined by the
20 appended claims.

Description of the Preferred Exemplary Embodiments

Two preferred exemplary embodiments of the present invention 10 and 100 are illustrated in Figures 1 through 7 (Figures 1, 4, 6, and 7; and Figures 1, 5, 6, and 7
25 respectively). Both embodiments teach the construction and use of readers capable of decoding "portable data files."

Each exemplary embodiment utilizes image capture means, pattern recognition means, and a real time display
30 for assisting a user in aiming, recognizing, confirming decodability, and decoding two-dimensional bar code symbols. The embodiments (10, 100) differ primarily in the particular construction and operation of their image capture means.

35 In a first exemplary embodiment 10 the image capture means 12 utilizes a one-dimensional photosensitive array 14 to read images in a horizontal (X) direction and

mechanical means 16 to read images in a vertical direction. Conversely, in a second exemplary embodiment 100 the image capture means 112 utilizes a two-dimensional photosensitive array 114 to read images in horizontal (X) and vertical (Y) directions (Figure 5).

Turning to the first exemplary embodiment 10, having image capture means 12, best illustrated in Figure 4, vertical components 16 of a two-dimensional bar code symbol 20 are read by rastering succeeding horizontal components 18 across a single line photosensitive array 14. This is accomplished, in such an exemplary embodiment, via a mirror 22 rotatably mounted about its horizontal plane. The mirror 22 is rotatably connected and driven by mirror control means 24. In a preferred exemplary embodiment an extremely low mass mirror prism (22) may be utilized and driven by solenoids, a piezo, or the like (24).

In this embodiment 10, an expanded 5,000 pixel single line photosensitive array 14 may be utilized. However, a 2,048 pixel one-dimensional line photosensitive array would also work with a reduced range. A special photosensitive array might also be designed with faster scan line times and reduced power requirements.

Vertical raster (Y) is variable under microprocessor 26 control (Figure 6). Likewise, the readout speed of the photosensitive array 14 is variable under microprocessor 26 control wherein the readout is preferably based on analyzed data recovered on each scan. Likewise, integration time and gain of sense amplifiers and filters acting on the photosensitive array 14 data may also be variable under microprocessor 26 control.

Additionally, an electronic option to read lower density bar code symbols could also be incorporated wherein every other, every third, or every fifth pixel might be read. Likewise, an electronic option to read high density short strings might also be incorporated

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wherein the left 1666, then center 1666, and then right 1666 pixels are read.

In another exemplary species of this embodiment 10 the photosensitive array shift register drives are built into the array. Electronic control of each charge well might also be provided such that wells not in use would not exist to the microprocessor 26. Such a configuration prevents dark currents from filling empty wells. Additionally, wells might also be created by the microprocessor 26 just prior to use. Thus, no special cleaning cycles will be necessary.

In another exemplary species of this embodiment 10 the interface could be more parallel wherein multiple photosensitive array 14 shift sections could each shift out their own output, for example, five outputs (each shifting 1000 pixels), or ten at 500 pixels, etc. Such a design would also utilize square pixel dimensions in order to maintain equal vertical and horizontal density.

The image capture means 12 may also include autofocus means. Autofocus could be accomplished via infrared or ultrasonic independent means, or via the use of photosensitive array scans in order to maximize transition sharpness of the received image, or the like. Likewise, the image capture means 12 would also include zoom controlled by the user.

Aiming of the reader 10 would be accomplished by physical proximity for close range (contact to two inches). The use of spotter beams is not desired because of their additional cost and tendency to washout in lighted areas. Aiming of the reader 10 for long range would be accomplished via a display 28 (< 1 to 20 plus feet). The display 28, in a preferred exemplary embodiment 10, would be a one inch CAT, dedicated LCD graphics screen, or even a terminal screen on an integrated scanner.

In such an embodiment 10 low resolution scanning may be performed while aiming. Image processing techniques

would then be utilized to display lines and shadows with sufficient aiming detail (Figures 1, 2, and 3). The microprocessor 26 would then utilize pattern recognition techniques to locate rectangular shapes (or other

5   information encoded shapes). Where the microprocessor 26 locates rectangular shapes (or other information encoded shapes) which might be decodable bar code symbols, the closest such shape to the center of the reader 10 window 30 would then be displayed on the display 28 in a

10   highlighted manner, e.g., flashing, reverse video, or the like. During this same time period the microprocessor 26 may also make an attempt to decode the contents within the highlighted area. Then, if the decode attempt is successful, the highlighted area could return to normal,

15   or the like, in order to notify the user that the decode was successful and that the user may either accept or reject the data. If the data is from the wrong bar code symbol, or the wrong portion of a correct bar code symbol, then the user may aim at a new area without accepting the

20   data.

      The use of zoom during aim induces jitter, therefore, in order to overcome this problem, more data may be scanned than is viewed on the display 28. If 1,000 pixels are collected but only 700 are viewed on the display 28,

25   then the microprocessor 26 may compare general patterns of each scan to detect motion and adjust the data sent to the display 28 to compensate for the motion. Additionally, as the displayed portion of the collected pixel picture reaches a boundary of the pixel picture, then the

30   displayed picture would start to move such that the center of the collected data is then shown as the displayed picture. In another species of an exemplary embodiment 10 all rectangular areas within the displayed area may be highlighted to indicate to a user which areas are probable

35   bar codes, and may annunciate that bar code symbol, or portion thereof, which the microprocessor 26 is currently attempting to decode.

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Illumination might come from an internal source, LED's or such, where the light 34 would be on continuously during the aiming and decoding. The light 34 would be variable under processor control in order to reduce power consumption. Additionally, local illumination would only be necessary over a nominal distance. Beyond this, ambient light would contribute more and more of the actual bar code illumination. While indoors, flood lighting or indoor overhead lights would be necessary. The intention of this design is such that if the user can see the bar code, the reader 10 will also, and decoding is possible.

Neural network and fuzzy logic processor programming and hardware design/architecture are both required. Digital signal processing techniques may also be used to help improve the basic data collected as far as signal level normalization within the bar code rectangular areas, taking advantage of bar codes still being printed in 2 colors only. Neural network concepts of weighted inputs and highly parallel processing would then be used during aiming and during a search for potential bar code 20 rectangles.

The use of concise dedicated functional neural processor, each with a single function, all reduced to silicon and all placed in a single ASIC is preferred. In this manner, 20 microprocessors, wherein one looks for a vertical line, another for a horizontal line, and another for angles, and the like, could all examine the same data base at the same time. Very high speed data (image) evaluation will also be utilized in a preferred embodiment for both aiming and decoding. The same microprocessors could also be responsible for power control in the image capture means 12. Additionally, it is preferred that not all processing functions be powered at all times or at the same time. Also, illumination would end and count (data) collection would cease after data was decoded. A communication processor could also be provided and such

communication processor could be functional until data was transferred.

A typical operation might be as follows: The user directs the reader 10 toward the bar codes 20 to be read (Figure 1). The user pulls a trigger means 40 to activate the aiming sequence. The user views the display 28 to verify reader 10 aim. The reader 10 auto focuses, starting with the focus setting of the previous read. The user views the display 28 and moves the reader 10 and starts to zoom as necessary as the desired bar code symbol 20 comes into view (Figure 2). The reader 10 continues to show the viewed field in the display 10 even as it decodes the bar code symbol 20. The reader 10 highlights the decoded bar code symbol 20 (Figure 3). The user may accept the decoded data via the trigger means 40, or the like. If the user does not want the data, he or she may move the reader 10 such that another desired bar code symbol 20 is centered and highlighted as decoded, or such that no bar code is highlighted and no decode would occur.

This feature is very beneficial in that one bar code can be selected on a page containing many adjacent codes without the sometimes impossible requirement of ensuring the scan line (laser) goes through only the desired code.

Figure 7 is a block diagram illustrating the functional block organization of an exemplary embodiment of the present invention. The optic string 200 allows for image focus and zoom. Both focus and zoom management are provided by the control processor 202. The input switches 204, such as the trigger 40, may be utilized to enable the scan function, or the like. While in the scan mode, focusing may be achieved according to at least two methods. As shown, there is a focus block function 206 which may utilize a separate range detection circuit (i.e., such as ultra-sonic or infra-red ranging means). This is the first type of focusing method. This method allows the control processor 202 to determine the range of an image from the scanner and move the lens assembly 208

accordingly without powering up, or at least without operating the image sensor 210 circuitry, data analyzing means 212, and display 214. In this fashion battery power is conserved. The second type of focusing method utilizes

5 the image sensor 210/processing means 212 to detect a lack of focus by data frequency analysis, i.e., moving the lens assembly 208 in order to maximize the high frequency content of the image data. The second type of focusing requires fewer parts, but more power and the initial

10 corrective movement may be in an incorrect direction. Using past direction history will improve chances of correct initial direction choice. Also any optically required focus adjustments due to zoom changes may be obtained from a look-up table within the control means and

15 included in the control of focus during zoom changes.

The image sensor may be either a single line several thousand pixel sensor (from at least 1000 to 5000 pixels depending on scan requirements) or an array sensor with from at least 500 to 1500 pixels in both the X and Y axis.

20 The preferred mode is to utilize an array sensor since it is both faster and requires fewer moving parts. However, cost and power requirements are greater with an array sensor.

As previously discussed, a one dimensional array

25 requires motion in the orthogonal direction to the pixel layout in order to obtain a 2-D image. The pixels in both sensors are square in dimension in order to maintain relative dimensions in both X and Y directions. One method of providing vertical dithering (back and forth) is

30 via a piezo element driven mirror within a folded optic path. However, a rotating polygon cylinder may also be utilized.

In order to reduce power and gain speed in honing in on an image, both image sensor methods allow partial

35 reading of the sensor fields. This means that during a line scan of a one line sensor, a programmably controlled number of pixels are skipped within the sensor on a cyclic

basis in order to obtain less dense scan information more rapidly. For instance, reading only every other, every third, or every fifth pixel means less taken to process the data. A less detailed image is acquired, but speed, not great detail is required for general aiming and setup. In the vertical direction, the mirror is moved further between samples to compensate for the partial pixel sample and in order to keep spatial relationships constant. With a two-dimensional array, the same partial pixel viewing is done in both directions at the same rate. Both sensor types allow controlled exposure time independent of cycle time.

The control processor means contains at least one microprocessor. The control processor is responsible for controlling focus, zoom, illumination (if necessary), sensor timing, power management, and communication to other system blocks. The control processor utilizes fuzzy logic decision structures to quickly focus and to analyze the overall image pattern. It is also responsible for controlling the sensor when retrieving high density pixel strings from portions of the sensor. This is useful when a low density pixel scan has enabled the processing function means to recognize a potentially decodable shape. A maximum density scan is then done over that portion of the sensor to try to determine if decode is possible. These high density scan portions might consist of the left, center, and right sections of the sensor. this may also be accomplished by programming start and stop points within the sensor to control which section is retrieved.

Under zoom conditions, user movement will be more apparent and objectionable. The processing function means controls the image sent to the display for assisting the user in aiming the scanner unit. The processing function means helps remove jitter caused by user motion by modifying the image sent to the display. The image sent to the display is a smaller portion of the actual scanned image. Fuzzy logic structures are again used to quickly

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determine patterns and shapes and track their movement.
The smaller (or subset) image that is displayed remains,
positioned as is, in the display until the displayed image
bumps up against a border of the true collected image.
5   Then the display image starts to move to the rate of user
movement. The processor means is continually working to
reduce jitter while also trying to recognize and decode
potentially decodable images.   It also enunciates
potentially decodable images in the display, for instance
10   surrounding an image with a solid outline, and marks fully
decoded images in another manner, such as reverse video.

Communication control means 220 communicates with the
control and processing means to provide interface to a
host system. The communication control means 220 may also
15   have its own microprocessor for handling protocol and data
transfer. In a tethered version 216 battery power may be
self contained or derived from a portable hand-held
terminal.   Where a wireless link 218 is utilized the
communication control means may also control the RF or IR
20   link.

Incorporation by Reference

The present invention may be constructed for use in
a docking type system for recharging/communicating with
the apparatus disclosed herein. A docking station which
25   might be adapted for use with the present invention is
disclosed in a copending application U.S. Serial №
07/451,322, filed December 15, 1989, which application is
incorporated herein by reference in its entirety as
illustrating arrangements which may be embodied in a
30   peripheral shell 260 (FIG. 10; 07/451,322). Likewise, the
disclosure of United States Patent № 4,877,949, issued
October 31, 1989, is also incorporated herein by
reference, in its entirety, as illustrating means for
focusing an image of optically readable information over
35   a substantial range of distances. Also incorporated
herein by reference is copending application U.S. Serial
№ 07/451,322, filed December 15, 1989, as illustrating a

display 14 (FIGS. 13 and 14) adapted to assist a user of an apparatus in reading optically readable information. Finally, also incorporated in its entirety herein by reference is copending application U.S. Serial №

5   07/143,921, filed January 14, 1988, as illustrating optically readable information digitizing and decoding means (FIGS. 7 through 18). While the invention has been described with a certain degree of particularity, it is manifest that many changes may be made in the details of

10   construction and the arrangement of components without departing from the spirit and scope of the disclosure. It is understood that the invention is not limited to the embodiments set forth herein for purposes of exemplification, but is to be limited only by the scope of

15   the appended claims including the full range of equivalency to which each element thereof is entitled.

   Thus, there has been shown and described an improved two-dimensional optical information reader which accomplishes at least all of the stated objects.

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I CLAIM:

1.   An apparatus for reading two-dimensional optical information, comprising:

(a)   a housing having an opening;

(b)   a photosensitive array mounted within said housing;

(b)   optical string means associated with said array and said opening of said housing for focusing optical information on said array;

(c)   array and optical string control means for controlling said array and optical string;

(d)   memory means for storing output from said array;

(d)   pattern recognition means for assisting a user in recognizing and confirming the decodability of optical information;

(e)   display means associated with said housing for displaying an image of said array output, as processed by said pattern recognition means, said display means further including optical information decodability indication means;

(f)   user feedback means, providing user interface with said apparatus, for facilitating user control over said optical string means, array, and display means;

(g)   decoding means for decoding optical information; and

(h)   electrical power supply means for providing power for the operation of said apparatus.

2.   The apparatus of claim 1, wherein said housing is of a size and shape suited for hand-held operation.

3.   The apparatus of claim 1, wherein said photosensitive array is a one-dimensional array.

4.   The apparatus of claim 3, wherein said optical string further comprises means for rastering one-dimensional image segments of a two-dimensional image onto the photosensitive regions of said array.

5. The apparatus of claim 1, wherein said photosensitive array is a two-dimensional array.

6. The apparatus of claim 1, further comprising zoom means for changing the image height of an object focused on said array.

7. The apparatus of claim 1, further comprising focusing means for variably focusing the image of an object on said array.

8. The apparatus of claim 1, wherein said memory is volatile.

9. The apparatus of claim 1, wherein said pattern recognition and optical information decoding means includes parallel processor means controlled at least in part by a fuzzy logic instruction set for both aiming and pattern recognition of likely optical information.

10. The apparatus of claim 1, wherein said optical string means further comprises auto focus means.

11. A process for reading two-dimensional optical information, comprising:

(a) directing a scanner at two-dimensional optical information to be read, wherein said scanner includes;

(1) a housing having an opening,

(2) a photosensitive array mounted within said housing,

(3) optical string means associated with said array and said light opening of said housing for focusing optical information on said array,

(4) array and optical string control means for controlling said array and optical string,

(5) memory means for storing output from said array,

(6) pattern recognition means for assisting a user in recognizing and

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confirming the decodability of optical
information,

(7) display means associated with said
housing for displaying an image of
said array output, as processed by
said pattern recognition means, said
display means further including
optical information decodability
indication means,

(8) user feedback means, providing user
interface with said scanner, for
facilitating user control over said
optical string means, array, and
display means,

(9) decoding means for decoding optical
information, and

(10) electrical power supply means for
providing power for the operation of
said scanner;

(b) activating said pattern recognition means via
said user feedback means such that a
representation of the image incident upon said
array is displayed by said display means;

(c) verifying that the image displayed by said
display means is optical information via said
decoding means;

(d) adjusting the aim of said scanner such that the
display optimally indicates that optical
information is both incident on said array as
displayed by said display means and decodability
indication means;

(e) selecting, via said user feedback means, at
least one of the steps of (1) accepting said
decoded optical information such that said
information is recorded and (2) rejecting the
optical information such that the decoded
optical information is declined.

12. The process of claim 11, wherein said housing is of a size and shape suited for hand-held operation.

13. The process of claim 11, wherein said photosensitive array is a one-dimensional array.

14. The process of claim 13, wherein said optical string further comprises means for rastering one-dimensional image segments of a two-dimensional image onto the photosensitive regions of said array.

15. The process of claim 11, wherein said photosensitive array is a two-dimensional array.

16. The process of claim 11, further comprising zoom means for changing the image height of an object focused on said array.

17. The process of claim 12, further comprising focusing means for variably focusing the image of an object on said array.

18. The process of claim 11, wherein said memory is volatile.

19. The process of claim 11, wherein said pattern recognition and optical information decoding means includes parallel processor means controlled at least in part by a fuzzy logic instruction set for both aiming and pattern recognition of likely optical information.

20. The process of claim 11, wherein said pattern recognition means is comprised of a neural network.

21. The process of claim 11, wherein said optical string means further comprises auto focus means.

22. The process of claim 11, further comprising the step of subtracting any user hand jitter from the image displayed to the user.

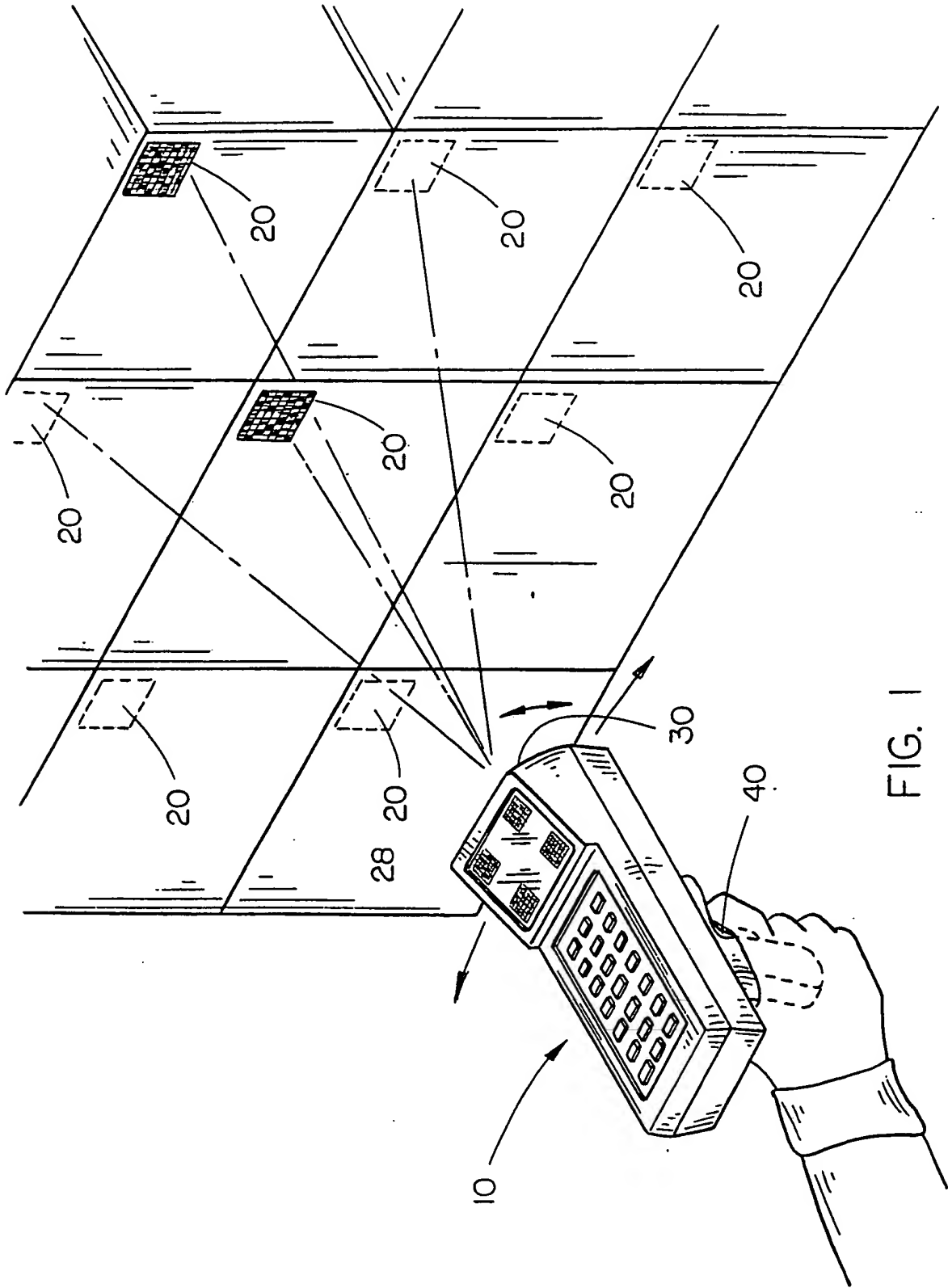23. The apparatus of claim 1, further comprising means for limiting image jitter displayed on the display.
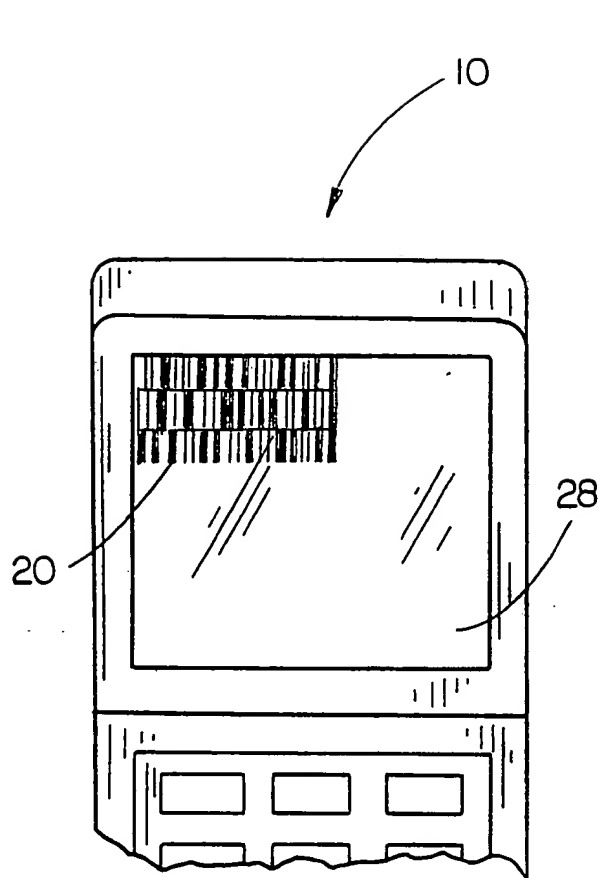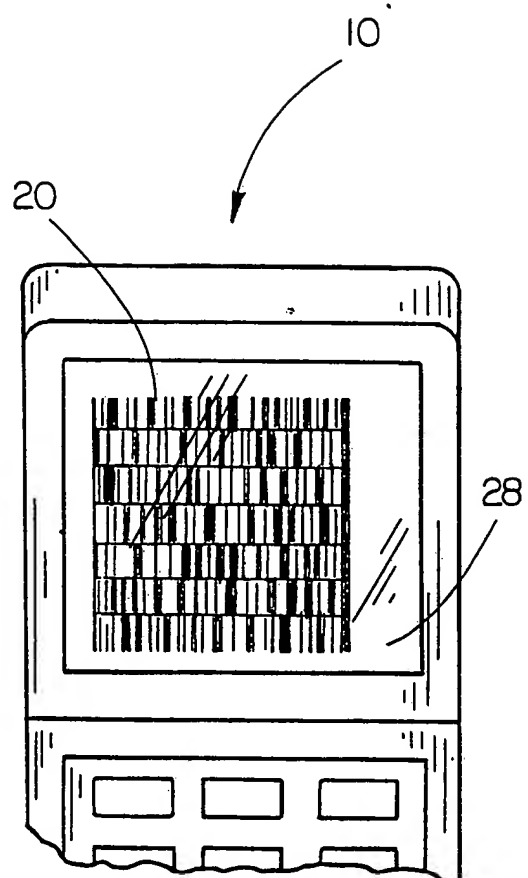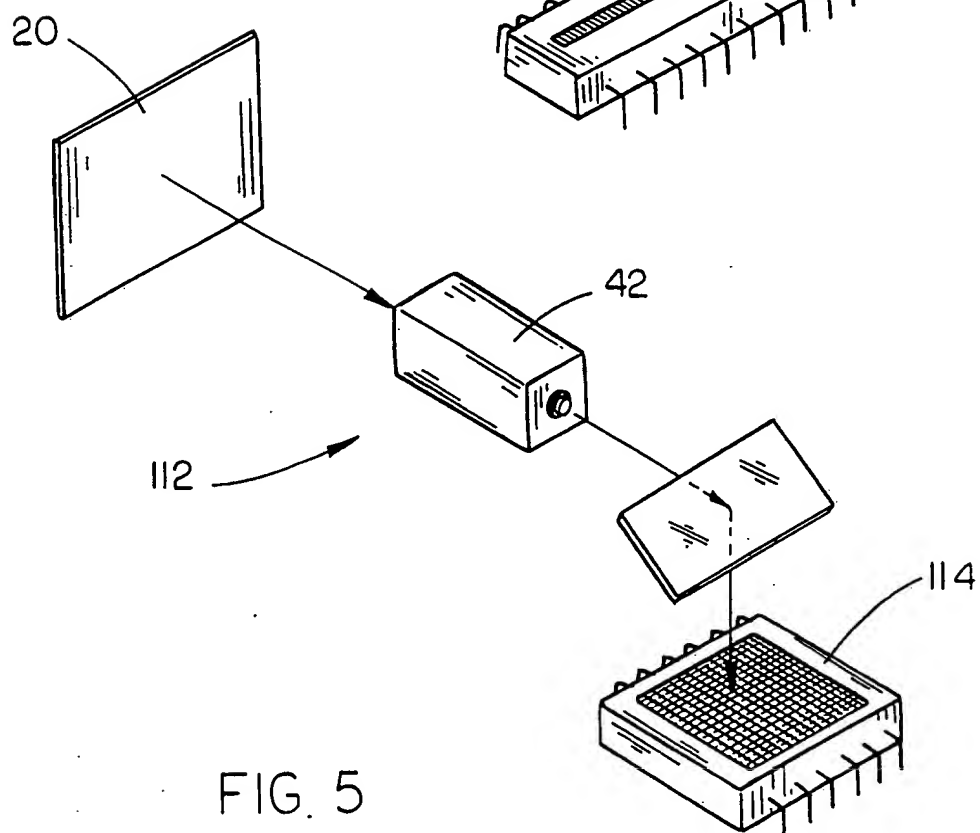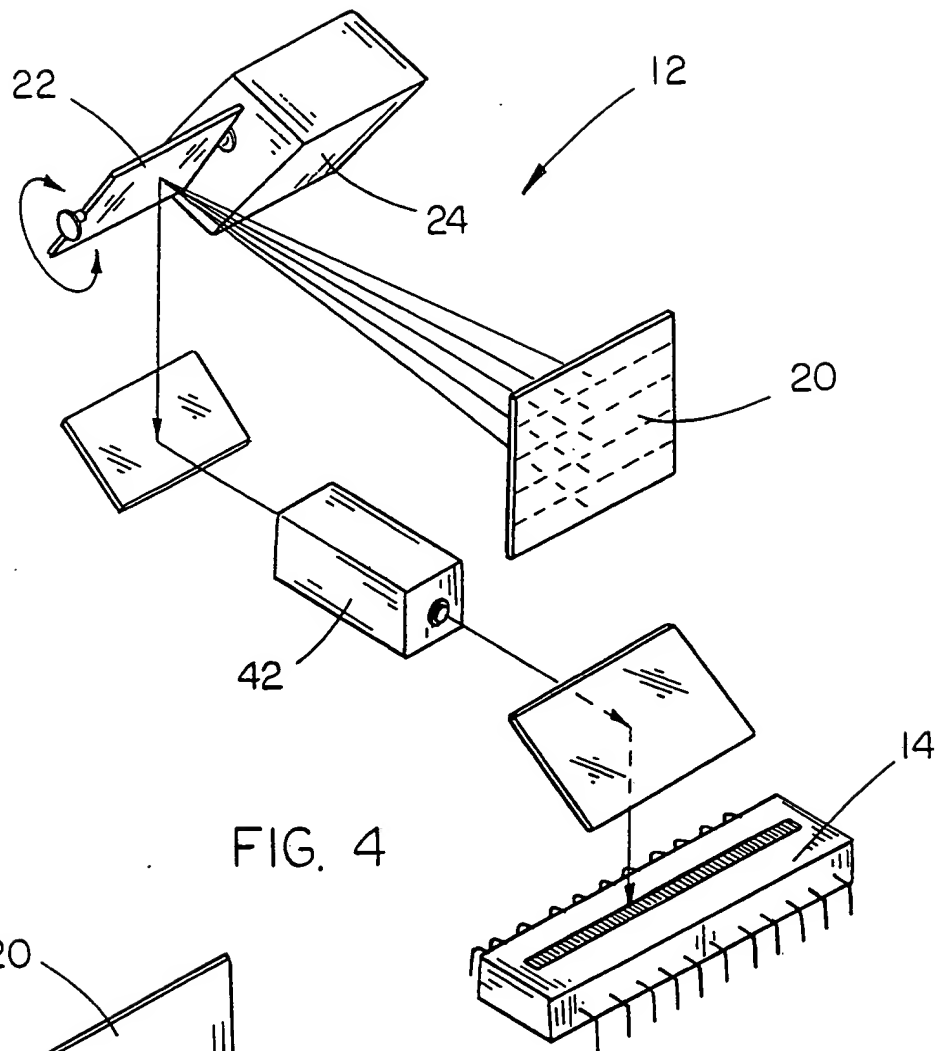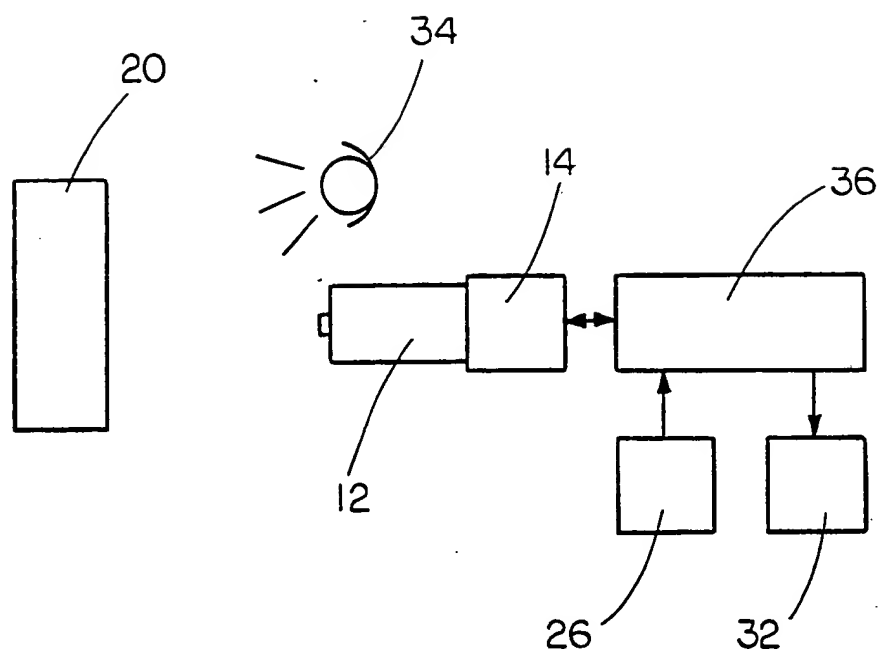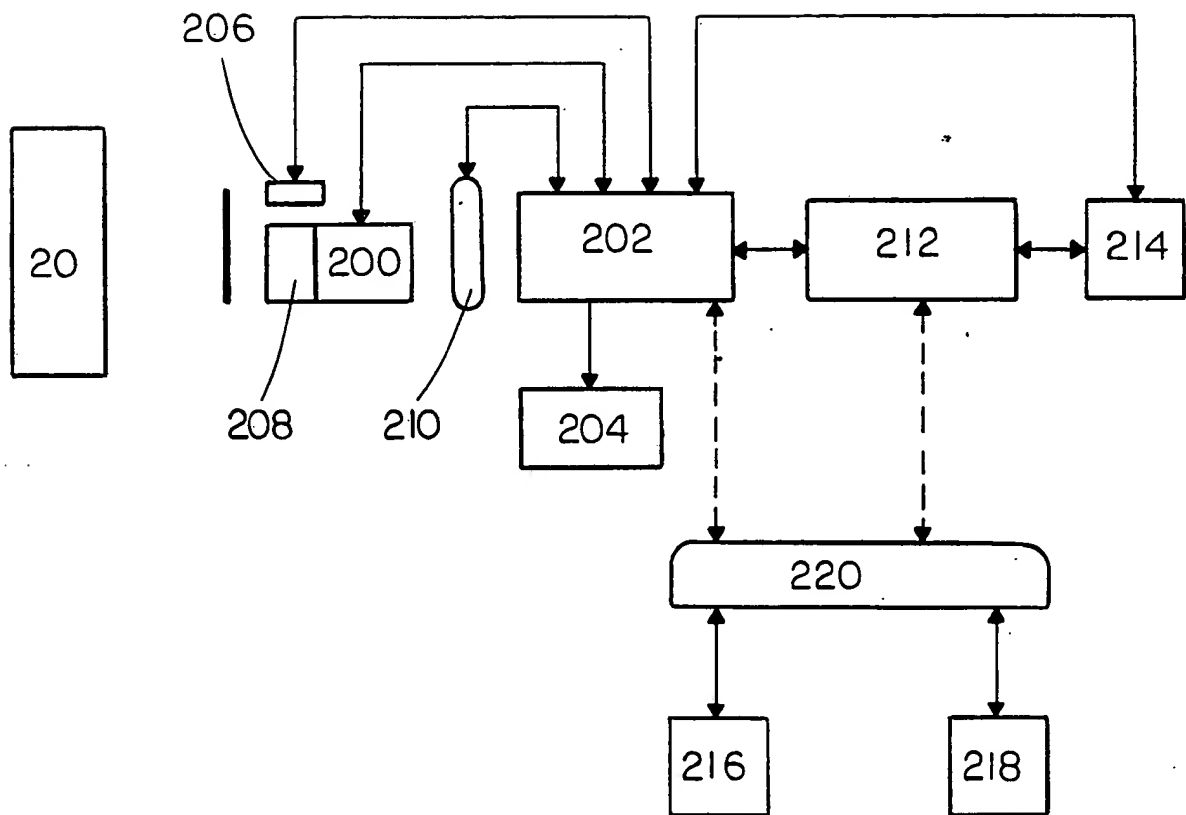
FIG. I

FIG. 2

FIG. 3

FIG. 4

FIG. 5

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FIG. 6

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FIG. 7

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: G06K 7/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DIALOG: 125, 340, 350, 351

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP, A1, 0349770 (OPTEL SYSTEMS, INC.), 10 January 1990 (10.01.90), page 3, line 16 - line 25, figure 3	1-23
Y	EP, A2, 0385478 (SYMBOL TECHNOLOGIES, INC.), 5 Sept 1990 (05.09.90), column 2, line 36 - column 16, line 21, figures 1-12	1-23
Y	US, A, 4044227 (J.P. HOLM ET AL), 23 August 1977 (23.08.77), figure 1, abstract	1-23

[X] Further documents are listed in the continuation of Box C.   [X] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 June 1993	1 3. 07. 93
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31 70) 340 3016	Authorized officer Roland Landström

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4360798 (J. SWARTZ ET AL), 23 November 1982 (23.11.82), column 6, line 33 - line 41, figures 2, 6 --	1-23
Y	IBM Technical Disclosure Bulletin, Volume 21, No 2, July 1978, (Armonk, New York, USA), E.R. Williams , "Two-dimensional Image Sensor Using One-dimensional Sensor array" page 436 - page 437 --	3-4
Y	Patent Abstracts of Japan, Vol 13,No 66, P-828, abstract of JP, A, 63-253483 (HITACHI LTD), 20 October 1988 (20.10.88) -- --------	1-23

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			JP-A-	60059480	05/04/85
			US-A-	4603262	29/07/86
			US-A-	4652750	24/03/87
EP-A2-	0385478	05/09/90	JP-A-	2268383	02/11/90
US-A-	4044227	23/08/77	NONE		
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			FR-A,B-	2438302	30/04/80
			US-A-	4251798	17/02/81